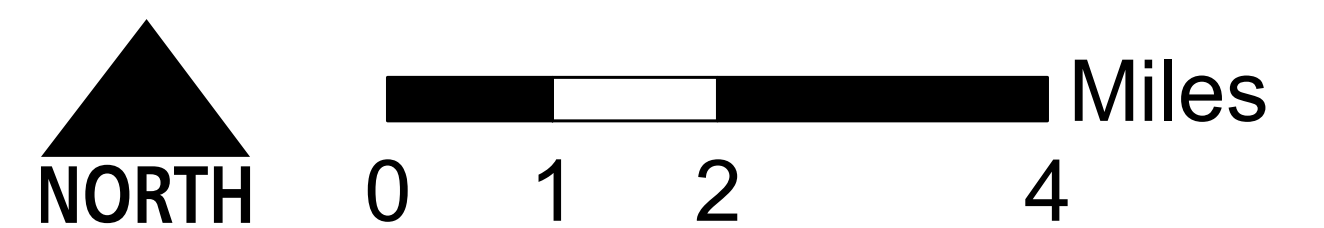
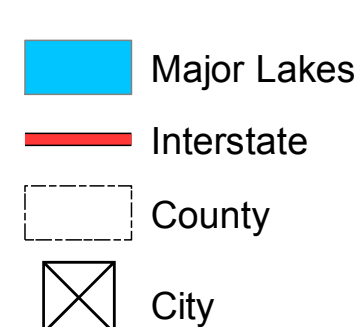
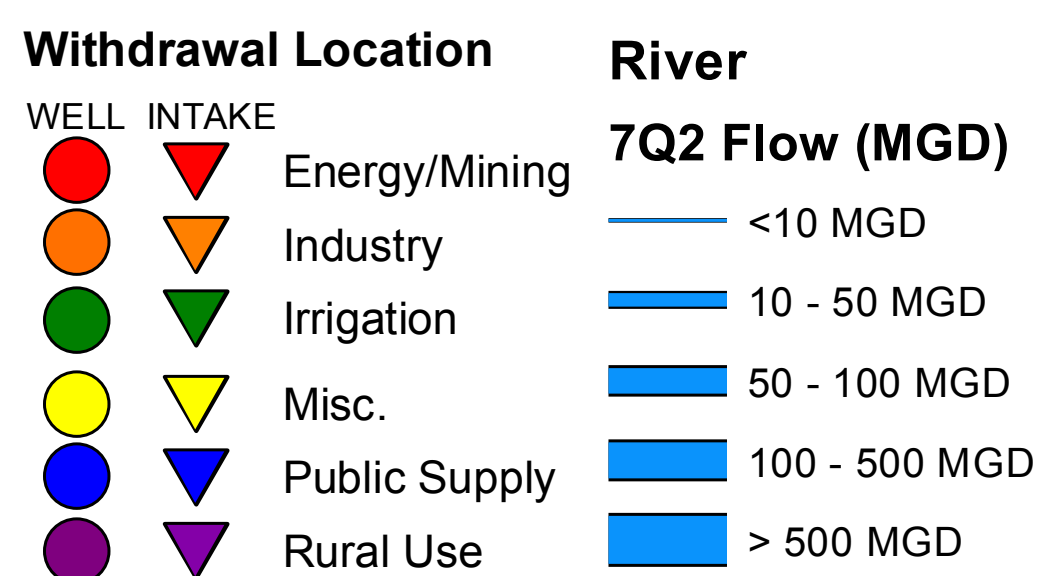


Water Resources and Use in Starke County

Data Sources: U.S. Geological Survey and Indiana Department of Natural Resources



BEDROCK AQUIFER SYSTEMS OF STARKE COUNTY, INDIANA

The occurrence of bedrock aquifers depends on the original composition of the rocks and subsequent changes which influence the hydraulic properties. Post-depositional processes, which promote jointing, fracturing, and solution activity of exposed bedrock, generally increase the hydraulic conductivity (permeability) of the upper portion of bedrock aquifer systems. Because permeability in many places is greatest near the bedrock surface, bedrock units within the upper 100 feet are commonly the most productive aquifers.

In Starke County thickness of unconsolidated deposits overlying bedrock ranges from approximately 35 feet in the southwest near the Kankakee River, to as much as 212 feet in the east-central portion of the county. Most of the bedrock aquifers, therefore, are under confined conditions. In other words, the potentiometric surface (water level) in most wells completed in bedrock rises above the top of the water-bearing formation.

The yield of a bedrock aquifer depends on its hydraulic characteristics and the nature of the overlying deposits. Shale and glacial till act as aquitards, restricting recharge to underlying bedrock aquifers. However, fracturing and/or jointing may occur in aquitards, which can increase recharge to the underlying aquifers. Hydraulic properties of the bedrock aquifers are highly variable.

The susceptibility of bedrock aquifer systems to surface contamination is largely dependent on the type and thickness of the overlying sediments. Because the bedrock aquifer systems have complex fracturing systems, once a contaminant has been introduced into a bedrock aquifer system, it will be difficult to track and remediate.

Two bedrock aquifer systems are identified for Starke County. They are the Devonian and Mississippian Coldwater, Ellsworth, and Antrim Shales Aquifer System and the Silurian and Devonian Carbonates Aquifer System.

Devonian and Mississippian -- Coldwater, Ellsworth, and Antrim Shales Aquifer System

In Starke County only the Ellsworth and Antrim Shale subgroups in the Coldwater, Ellsworth and Antrim Shales Aquifer System. The Ellsworth Shale is comprised of alternating beds of gray-green to brownish black shale. The Antrim Shale is typically described as brownish-black shale. However, in some places the lower portion of the Antrim Shale may contain some limestone. The subgroup area for the Antrim Shale includes most of central Starke County and the subgroup area for the Ellsworth shale includes the northwestern part of the county. In general, reported thickness of the Antrim and Ellsworth shales in the subgroup area ranges from 10 to 129 feet.

Few wells utilize the Coldwater, Ellsworth and Antrim Shales Aquifer System. Shale is commonly considered an aquitard and therefore, the system is an extremely limited groundwater resource. In Starke County, most domestic wells either produce from the overlying unconsolidated deposits or penetrate through the shale in favor of the underlying Silurian and Devonian Carbonates. However, a few wells report capacities up to 10 gallons per minute (gpm). Reported depth to bedrock generally ranges from 35 to 153 feet. It is likely that these wells are under the influence of overlying sands and gravels.

Because the permeability of shale materials is considered low, susceptibility to contamination introduced at or near the surface is low. However, areas where outwash deposits directly overlie fractured bedrock are at moderate to high risk to contamination.

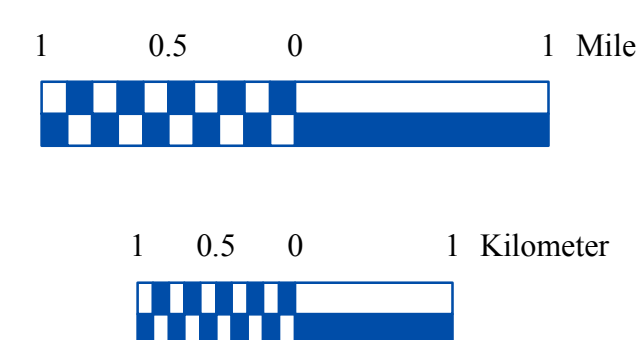
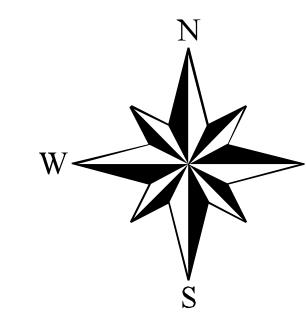
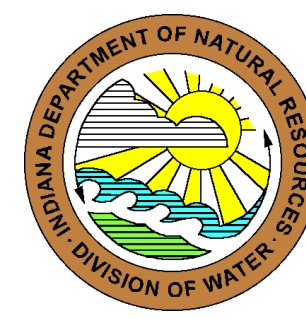
Silurian and Devonian Carbonates Aquifer System

The Silurian and Devonian Carbonates Aquifer System subgroups along the southeastern and south-central portions of Starke County. The system includes Devonian age carbonate units of the Muscatatuck Group. Total thickness of the Devonian bedrock generally ranges from about 85 to 150 feet.

Few wells are reported in the Silurian and Devonian Carbonates Aquifer System. However, in some isolated areas drillers bypass the unconsolidated resources and utilize the underlying bedrock aquifer. Depth to the bedrock surface is approximately 150 feet, although most wells that reportedly use the system penetrate through the overlying Ellsworth and Antrim shales outside the subgroup area.

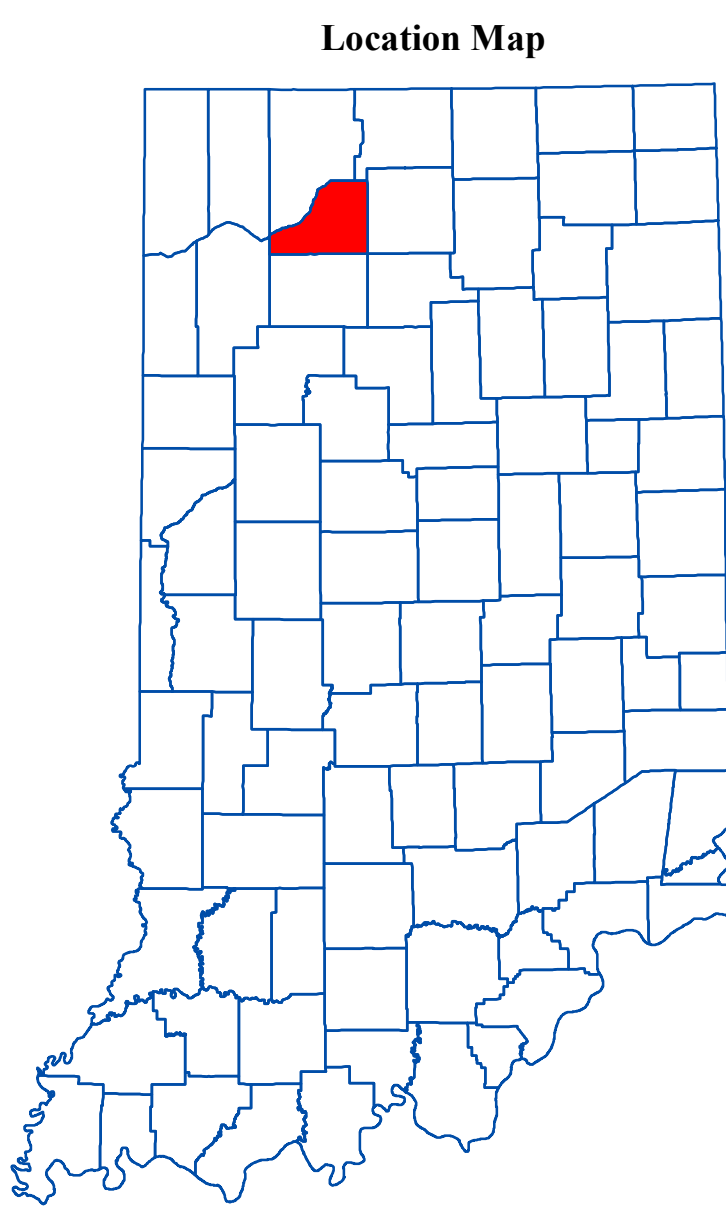
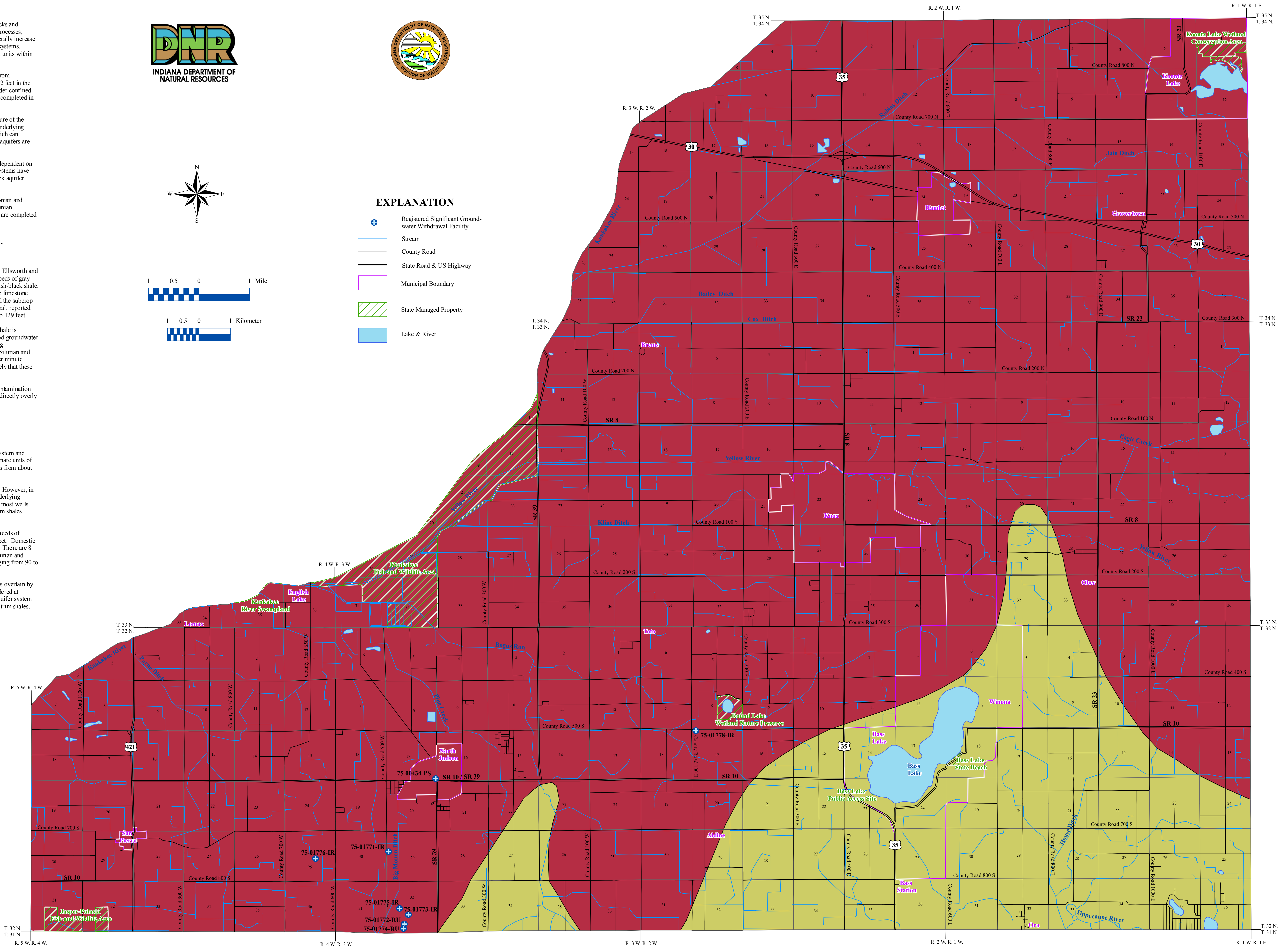
The Silurian and Devonian Carbonates Aquifer System is capable of meeting the needs of domestic and some high-capacity users. Total well depths range from 80 to 301 feet. Domestic yields generally range from 1 to 45 gpm with static water levels from 6 to 36 feet. There are 8 registered significant groundwater withdrawal facilities (10 wells) utilizing the Silurian and Devonian Carbonates Aquifer System with reported yields of individual wells ranging from 90 to 850 gpm.

Much of the Silurian and Devonian Carbonates Aquifer System in Starke County is overlain by sands and gravels with intermittent clay deposits. These areas are generally considered at moderate to high risk to contamination. However, most wells completed in this aquifer system are outside the subgroup area and penetrate through the overlying Ellsworth and Antrim shales. These areas are at moderate to low risk to contamination.



EXPLANATION

- Registered Significant Groundwater Withdrawal Facility
- Stream
- County Road
- State Road & US Highway
- Municipal Boundary
- State Managed Property
- Lake & River



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Bedrock Aquifer Systems of Starke County, Indiana

by
Randal D. Maier
Division of Water, Resource Assessment Section

October 2010

UNCONSOLIDATED AQUIFER SYSTEMS OF STARKE COUNTY, INDIANA

Five unconsolidated aquifer systems have been mapped in Starke County: the Eolian Sands; the Valparaiso Outwash Apron; the Kankakee / Plymouth Complex; the Kankakee; and the Wabash River and Tributaries Outwash System. Characteristics of the Kankakee, the Eolian Sands and the Valparaiso Outwash Apron have been described and mapped as part of the previously published regional basin study report; Water Resource Availability in the Kankakee River Basin, Indiana, IDNR, 1990. Although characteristics and descriptions of the basin study aquifer systems are generalized over large portions of northern Indiana, the descriptions of the aquifer systems have been modified here to accommodate the individuality of Starke County. Boundaries of all aquifer systems described are commonly gradational, and individual aquifers may extend across aquifer system boundaries.

Thicknesses of unconsolidated sediments that overlie bedrock are quite variable in Starke County. Total thickness ranges from approximately 35 feet in the southwest near the Kankakee River, to as much as 212 feet in the east-central portion of the county. Approximately 90 percent of all located wells are completed in unconsolidated deposits.

Regional estimates of aquifer susceptibility to contamination from the surface can differ considerably due to variation within geologic environments. In addition, man-made structures such as poorly constructed water wells, unplugged or improperly abandoned wells, and open excavations, can provide contaminant pathways that bypass the naturally protective clays.

Eolian Sands Aquifer System

The Eolian Sands Aquifer System includes portions previously mapped as part of the regional basin study report; Water Resource Availability in the Kankakee River Basin, Indiana, IDNR, 1990, and is mapped throughout the central portion of Starke County from the Town of San Pierre and continuing northeast. General characteristics of this system involve windblown (eolian) sand at the surface with, in some areas, intermittent clay beneath that separates surface deposits from the deeper aquifer resource. In some isolated areas, either the upper windblown sands are not present, or, clay that separates the upper eolian sands from the lower outwash aquifer is not present.

Upper confining clay typically ranges from 1 to 50 feet thick with the overlying eolian sands generally ranging up to 30 feet thick. Wells completed in the Eolian Sands Aquifer System are typically from 50 to 105 feet deep. Aquifer thickness ranges from 7 to 40 feet.

This system is capable of meeting the needs of domestic and some high-capacity users. Domestic well yields are commonly 15 to 65 gallons per minute (gpm). Static water levels range from 5 to 15 feet below surface with reports of flowing wells. There are 25 registered significant groundwater withdrawal facilities (32 wells) utilizing this system with reported yields ranging from 75 to 1500 gpm.

This aquifer system is generally not very susceptible to surface contamination where intratill sand and gravel units are overlain by thick till deposits. However, areas where overlying clays are thin or absent are at moderate to high risk of contamination.

Valparaiso Outwash Apron Aquifer System

The Valparaiso Outwash Apron Aquifer System was previously mapped as part of the regional basin study report; Water Resource Availability in the Kankakee River Basin, Indiana, IDNR, 1990. Unconsolidated deposits are associated with the southern limit of a wide band of glacially derived outwash that overlies bedrock or clay. This system is mapped along much of the northwestern part of Starke County.

Total depth of wells completed in Starke County range from 17 to 148 feet with up to 94 feet of continuous aquifer sands and gravels. Where present, intermittent clay ranging from 3 to 120 feet thick separates upper outwash sands and gravels from the underlying aquifer.

This system is capable of meeting the needs of domestic and high-capacity users. Domestic well yields are commonly 10 to 60 gpm with static water levels that range from 2 to 28 feet below surface. There are 25 registered significant groundwater withdrawal facilities (61 wells) utilizing this system with reported high-capacity yields ranging from 138 to 1300 gpm.

This aquifer system is generally not very susceptible to surface contamination because intratill sand and gravel units are overlain by thick till deposits. However, wells that utilize the shallow sands and gravels are at moderate to high risk of surface contamination.

Kankakee / Plymouth Complex Aquifer System

The Kankakee / Plymouth Complex Aquifer System is mapped in portions of southern Starke County. Complex multiple glacial advances resulted in a sequence of multiple, stacked, till and outwash units that are quite variable in position and thickness. Characteristics of this system may include surface sands (primarily windblown deposits that are not used as an aquifer resource) that overlie a thick clay cap with discontinuous intratill sands and gravels above the primary aquifer unit. In places the system exhibits multiple sand and gravel deposits above the primary aquifer resource that are also a potential source of groundwater.

Few wells are reported in the Kankakee / Plymouth Complex. Well depths, however, generally range from 38 to 123 feet. The sand and gravel deposits vary from thin to massive and are typically discontinuous and overlain by a thick till. Total accumulative unconsolidated thicknesses above the aquifer unit are generally 10 to 108 feet of clay with the discontinuous sands and gravels typically 7 to 22 feet thick. The deeper, more productive aquifer deposits range from 5 to 64 feet thick.

The Kankakee / Plymouth Complex Aquifer System is capable of meeting the needs of domestic and high-capacity users. Typical domestic yields range from 10 to 50 gpm. Static water levels commonly range from 5 to 38 feet below surface. There are 4 registered significant groundwater withdrawal facilities (5 wells) with reported yields that range from 700 to 1000 gpm.

This aquifer system is not very susceptible to contamination where clay deposits overlie aquifer materials. However, in places clay deposits are thin or not present; these areas are at moderate to high risk to surface contamination.

Kankakee Aquifer System

In Starke County the Kankakee Aquifer System is mapped in the northwestern and southwestern areas of the county and includes previously mapped portions as part of the regional basin study report; Water Resource Availability in the Kankakee River Basin, Indiana, IDNR, 1990.

Few wells are reported in the Kankakee Aquifer System in Starke County. Total well depths range from 19 to 105 feet with sands and gravels up to 53 feet thick. In isolated areas some intermittent clay deposits may be present. Static water levels range from 3 to 24 feet below surface. This system is capable of meeting the needs of domestic and some high-capacity users. There are 7 registered significant groundwater withdrawal facilities (9 wells) with yields that range from 80 to 1100 gpm. The system is at moderate to high risk to contamination.

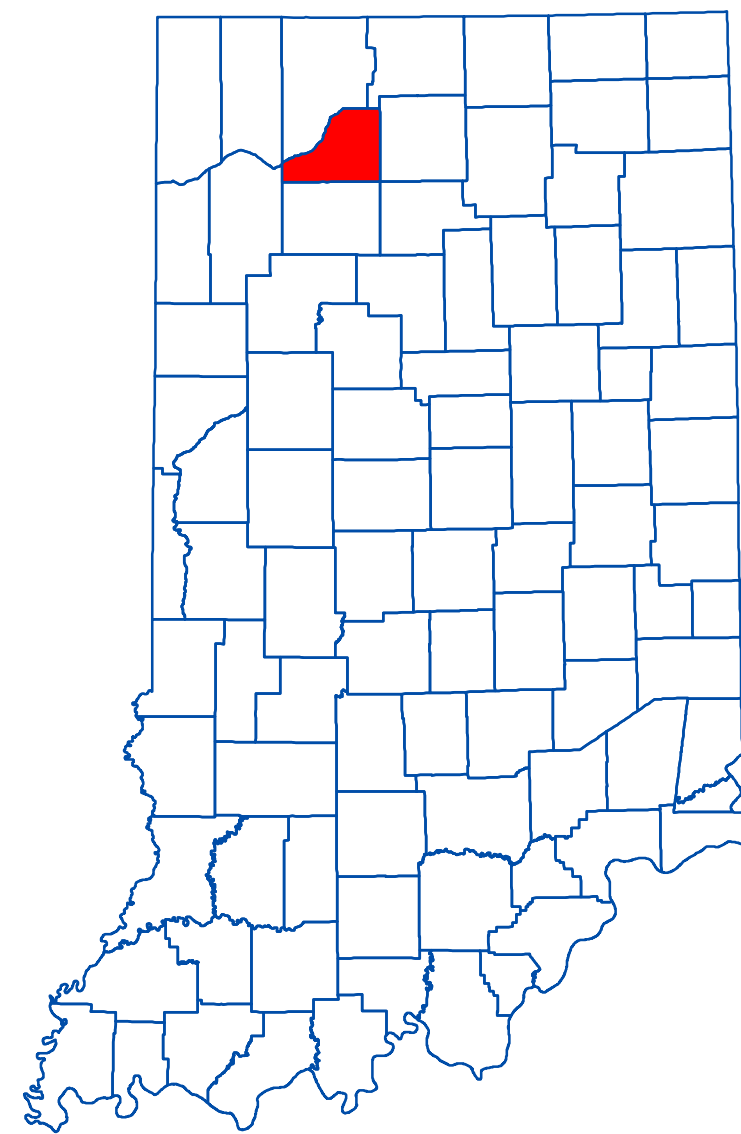
Wabash River and Tributaries Outwash Aquifer System

In Starke County the Wabash River and Tributaries Outwash Aquifer System includes thick, glacially derived outwash deposits along with recent alluvial deposits that cap the outwash deposits in places. The system is mapped in the southeastern part of the county along the floodplain of the Tippecanoe River.

There are no domestic wells reported in this system in Starke County. However, there are 2 registered significant groundwater withdrawal facilities (3 wells) in the outwash system in Starke County. Well depths range from 60 to 90 feet below the surface with total thickness reported as continuous sand and gravel. In places, aquifer materials may be capped by silt, clay or sandy clay. Individual wells report yields ranging from 450 to 1050 gpm with static water levels of 6 and 15 feet below the surface. In nearby Pulaski County domestic wells are reported to yield 15 to 60 gpm.

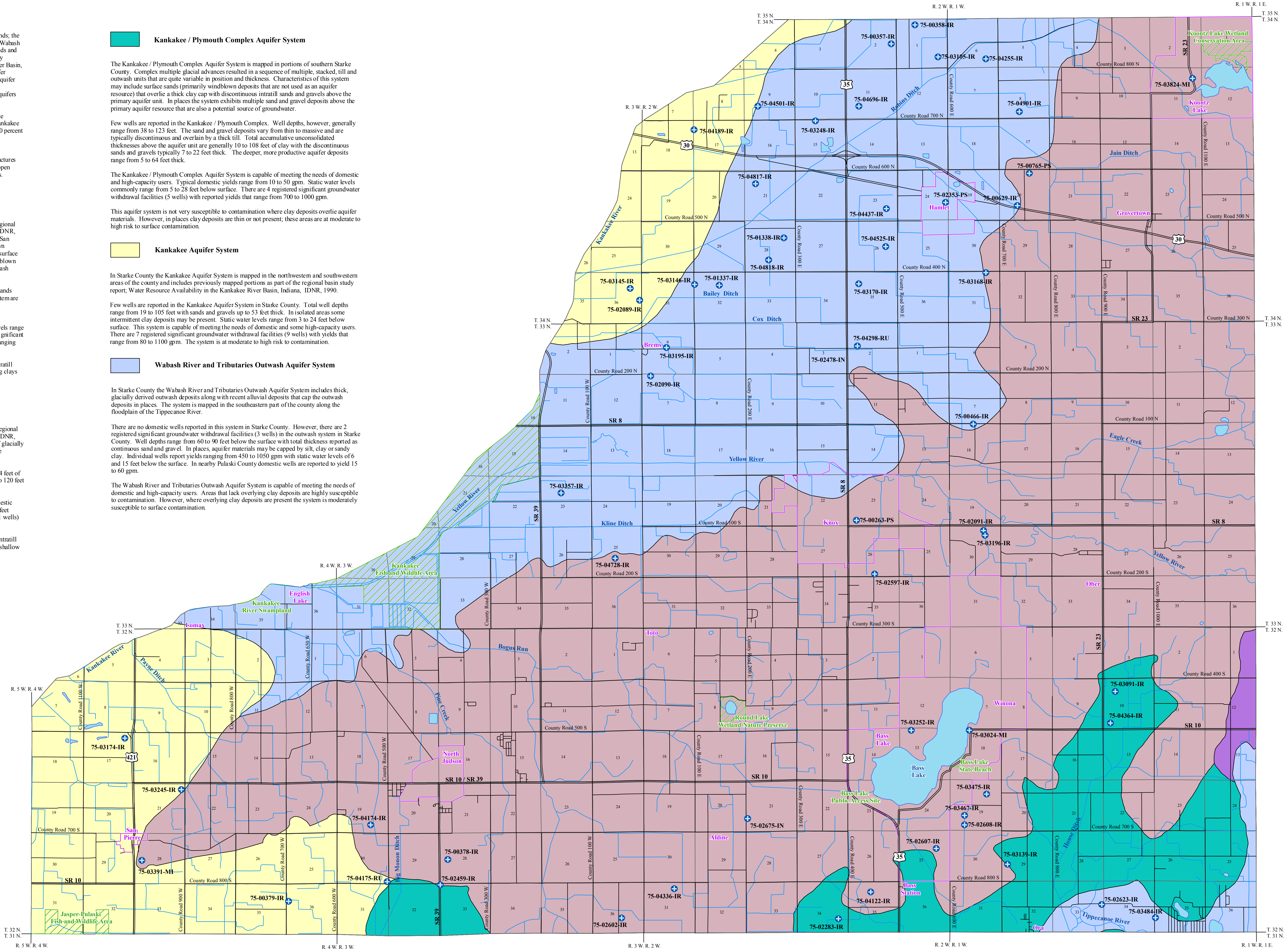
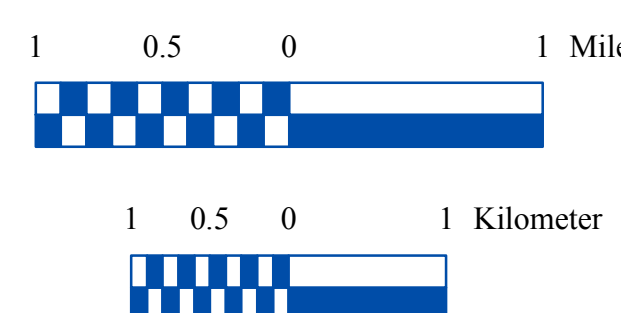
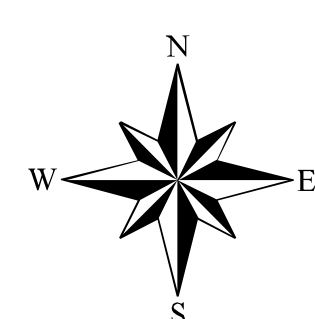
The Wabash River and Tributaries Outwash Aquifer System is capable of meeting the needs of domestic and high-capacity users. Areas that lack overlying clay deposits are highly susceptible to contamination. However, where overlying clay deposits are present the system is moderately susceptible to surface contamination.

Location Map



EXPLANATION

- Registered Significant Groundwater Withdrawal Facility
- Stream
- County Road
- State Road & US Highway
- Municipal Boundary
- State Managed Property
- Lake & River



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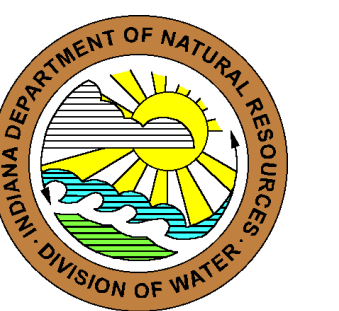
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Unconsolidated Aquifer Systems of Starke County, Indiana

by
Randall D. Maier
Division of Water, Resource Assessment Section

October 2010



POTENTIOMETRIC SURFACE MAP OF THE UNCONSOLIDATED AQUIFERS OF STARKE COUNTY, INDIANA

Starke County, Indiana is located in the northwest section of the state. The southwestern and southeastern portions of the county are situated within the Upper Wabash River Basin with the remaining parts located in the Kankakee River Basin.

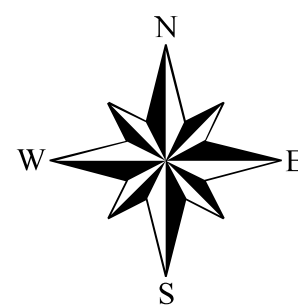
The Potentiometric Surface Map (PSM) of the unconsolidated aquifers of Starke County was mapped by contouring the elevations of approximately 870 static water-levels reported on well records received primarily over a 50 year period. These wells are completed in aquifers at various depths, and typically, under confined conditions (bounded by impermeable layers above and below the water bearing formation). However, some wells were completed under unconfined (not bounded by impermeable layers) settings. The potentiometric surface is a measure of the pressure on water in a water bearing formation. Water in an unconfined aquifer is at atmospheric pressure and will not rise in a well above the top of the water bearing formation, in contrast to water in a confined aquifer which is under hydrostatic pressure and will rise in a well above the top of the water bearing formation.

Static water-level measurements in individual wells used to construct county PSM's are indicative of the water-level at the time of well completion. The groundwater level within an aquifer constantly fluctuates in response to rainfall, evapotranspiration, groundwater movement, and groundwater pumping. Therefore, measured static water-levels in an area may differ due to local or seasonal variations. Because fluctuations in groundwater are typically small, static water-levels can be used to construct a generalized PSM. Groundwater flow is naturally from areas of recharge toward areas of discharge. As a general rule, but certainly not always, groundwater flow approximates the overlying topography and intersects the land surface at major streams.

Universal Transverse Mercator (UTM) coordinates for the water wells were either physically obtained in the field, determined through address geocoding, or reported on water well records; however, the location of the majority of the water well records used to make the PSM were not field verified. Elevation data were either obtained from topographic maps or a digital elevation model. Quality control/quality assurance procedures were utilized to refine or remove data where errors were readily apparent.

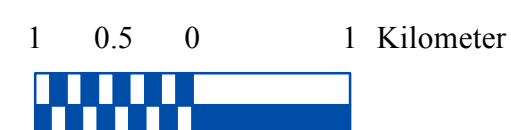
Unconsolidated static water levels in Starke County range from a high of 738 feet mean sea level (msl) in the northeastern section of the county, to a low of 652 feet msl in the southwestern portion. Groundwater flow direction in the Kankakee River Basin is to the West toward the Kankakee River, and generally to the south toward the Tippecanoe River within the Upper Wabash River Basin.

The county PSM can be used to define the regional groundwater flow path and to identify significant areas of groundwater recharge and discharge. County PSM's represent overall regional characteristics and are not intended to be a substitute for site-specific studies.

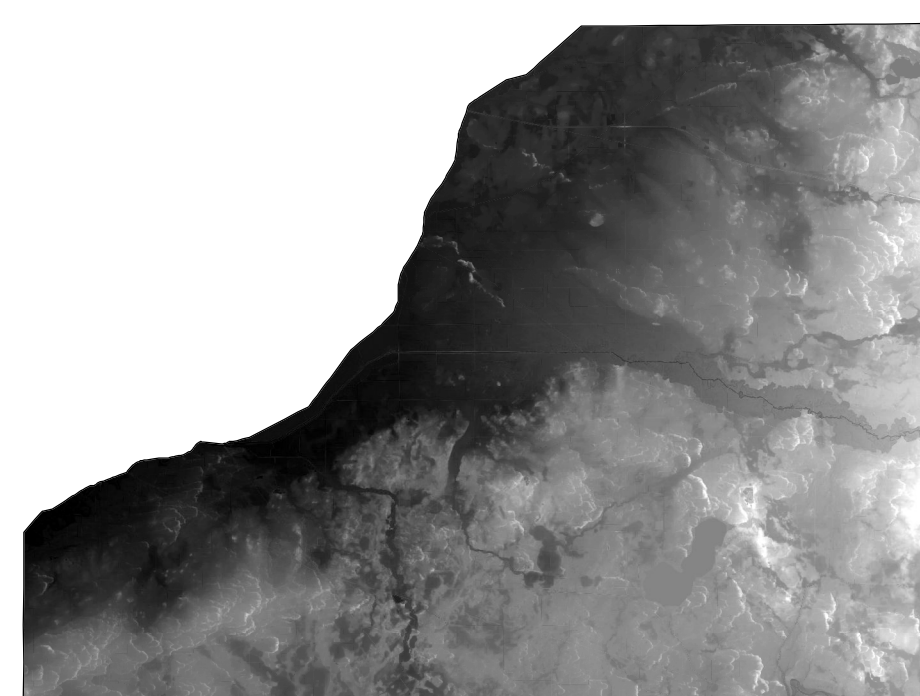


EXPLANATION

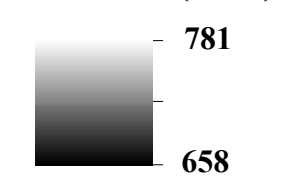
- Line of equal elevation, in feet above mean sea level
- Potentiometric Contour interval 10 feet
- Basin Boundary
- Stream
- County Road
- State Road
- US Highway
- Municipal Boundary
- State Managed Property
- Lake & River



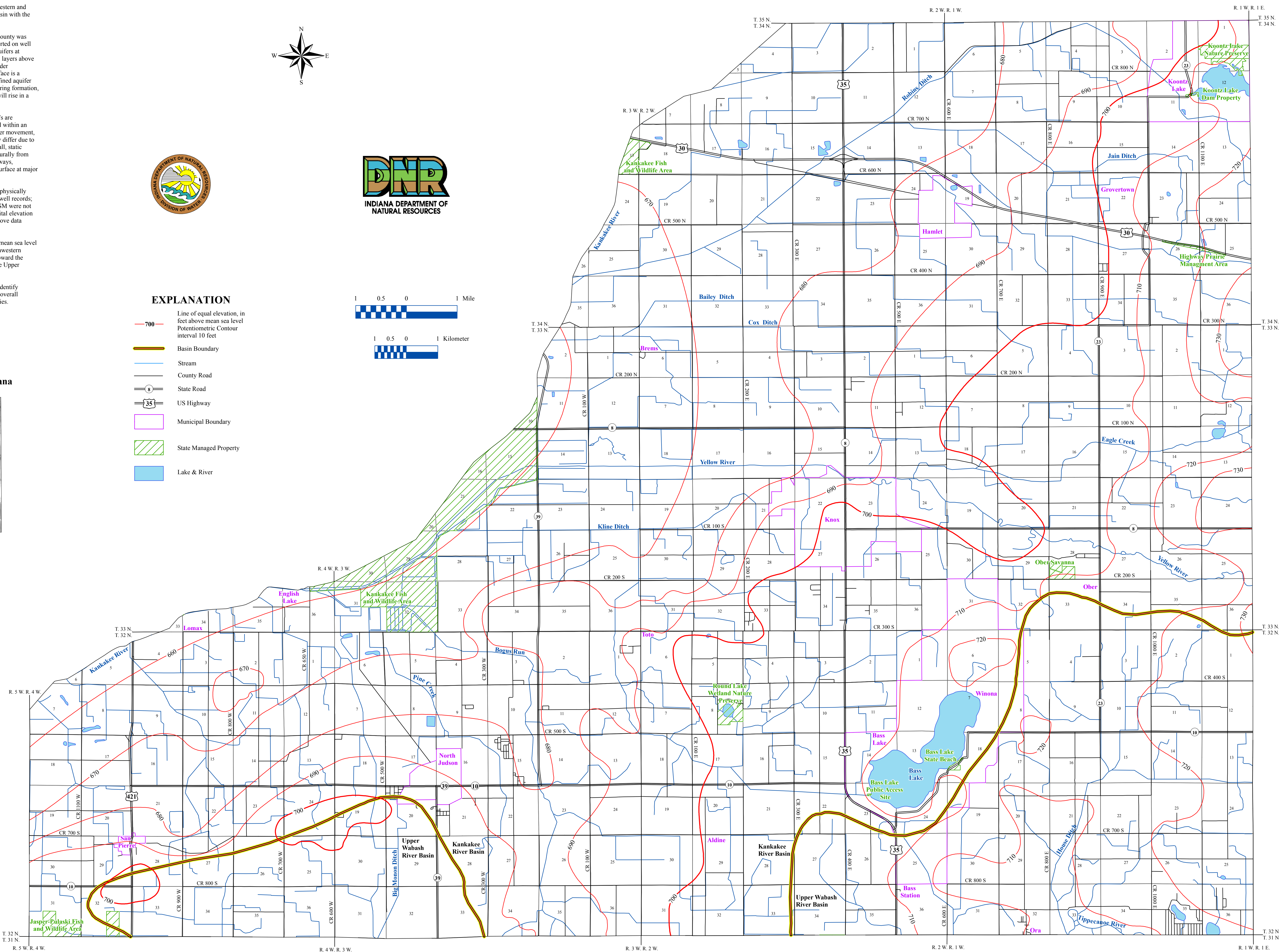
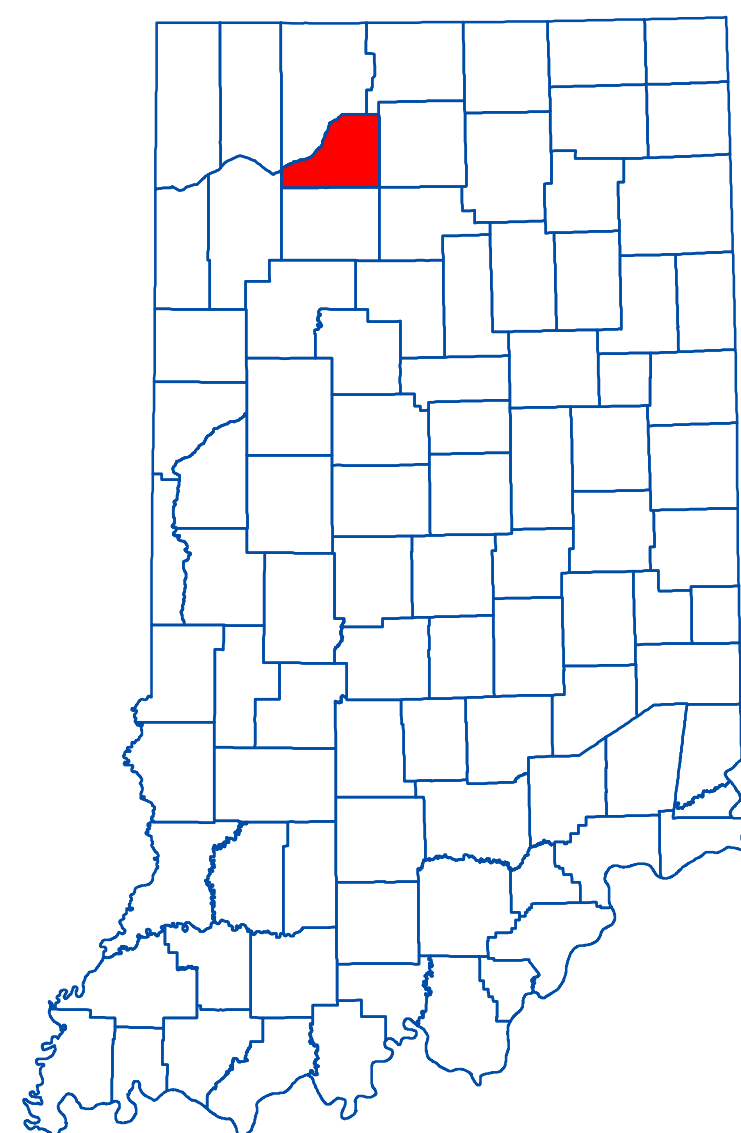
Digital Elevation Model of Starke County, Indiana



Elevation (feet)



Location Map



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Potentiometric Surface Map of the Unconsolidated Aquifers of Starke County, Indiana

by
Robert K. Schmidt
Division of Water, Resource Assessment Section

February 2013

Map generated by Robert K. Schmidt and Joel D. Sanderson
Indiana Department of Natural Resources,
Division of Water, Resource Assessment Section

Starke County

